

FORM PTO-1390 (Modified) (REV 11-2000)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER <b>219734US3PCT</b>
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371				U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR <b>101049622</b>
INTERNATIONAL APPLICATION NO. <b>PCT/JP99/04516</b>	INTERNATIONAL FILING DATE <b>23 August 1999</b>	PRIORITY DATE CLAIMED <b>None</b>		
TITLE OF INVENTION <b>GAS GENERATOR FOR ACTUATING VEHICLE OCCUPANT RESTRAINT DEVICE</b>				
APPLICANT(S) FOR DO/EO/US <b>KUBO Dairi et al.</b>				
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:				
<ol style="list-style-type: none"> <li>1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li>2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li>3. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.</li> <li>4. <input checked="" type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (Article 31).</li> <li>5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371 (c) (2))             <ol style="list-style-type: none"> <li>a. <input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau).</li> <li>b. <input checked="" type="checkbox"/> has been communicated by the International Bureau.</li> <li>c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</li> </ol> </li> <li>6. <input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).             <ol style="list-style-type: none"> <li>a. <input checked="" type="checkbox"/> is attached hereto.</li> <li>b. <input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4).</li> </ol> </li> <li>7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))             <ol style="list-style-type: none"> <li>a. <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau).</li> <li>b. <input type="checkbox"/> have been communicated by the International Bureau.</li> <li>c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</li> <li>d. <input checked="" type="checkbox"/> have not been made and will not be made.</li> </ol> </li> <li>8. <input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</li> <li>9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).</li> <li>10. <input type="checkbox"/> An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).</li> <li>11. <input type="checkbox"/> A copy of the International Preliminary Examination Report (PCT/IPEA/409).</li> <li>12. <input checked="" type="checkbox"/> A copy of the International Search Report (PCT/ISA/210).</li> </ol>				
Items 13 to 20 below concern document(s) or information included:				
<ol style="list-style-type: none"> <li>13. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</li> <li>14. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</li> <li>15. <input checked="" type="checkbox"/> A <b>FIRST</b> preliminary amendment.</li> <li>16. <input type="checkbox"/> A <b>SECOND</b> or <b>SUBSEQUENT</b> preliminary amendment.</li> <li>17. <input type="checkbox"/> A substitute specification.</li> <li>18. <input type="checkbox"/> A change of power of attorney and/or address letter.</li> <li>19. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.</li> <li>20. <input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4).</li> <li>21. <input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).</li> <li>22. <input type="checkbox"/> Certificate of Mailing by Express Mail</li> <li>23. <input checked="" type="checkbox"/> Other items or information:</li> </ol>				
PCT/IB/308/Form PTO-1449/Drawings (3 sheets)				

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR <b>10/049622</b>	INTERNATIONAL APPLICATION NO. <b>PCT/JP99/04516</b>	ATTORNEY'S DOCKET NUMBER <b>219734US3PCT</b>
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24. The following fees are submitted:

**BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):**

<input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO .....	\$1040.00
<input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO .....	\$890.00
<input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO .....	\$740.00
<input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) .....	\$710.00
<input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) .....	\$100.00

**CALCULATIONS PTO USE ONLY**

**ENTER APPROPRIATE BASIC FEE AMOUNT =**

**\$890.00**

Surcharge of **\$130.00** for furnishing the oath or declaration later than  20  30 months from the earliest claimed priority date (37 CFR 1.492 (e)).

**\$0.00**

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	7 - 20 =	0	x \$18.00	<b>\$0.00</b>
Independent claims	1 - 3 =	0	x \$84.00	<b>\$0.00</b>
Multiple Dependent Claims (check if applicable).			<input type="checkbox"/>	<b>\$0.00</b>

**TOTAL OF ABOVE CALCULATIONS =** **\$890.00**

<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.	<b>\$0.00</b>
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**SUBTOTAL =** **\$890.00**

Processing fee of <b>\$130.00</b> for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).	<b>\$0.00</b>
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**TOTAL NATIONAL FEE =** **\$890.00**

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable).	<input type="checkbox"/>	<b>\$0.00</b>
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**TOTAL FEES ENCLOSED =** **\$890.00**

	<b>Amount to be:</b>	<b>\$</b>
	<b>refunded</b>	<b>\$</b>

**charged** **\$**

- A check in the amount of **\$890.00** to cover the above fees is enclosed.
- Please charge my Deposit Account No. \_\_\_\_\_ in the amount of \_\_\_\_\_ to cover the above fees. A duplicate copy of this sheet is enclosed.
- The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **15-0030** A duplicate copy of this sheet is enclosed.
- Fees are to be charged to a credit card. **WARNING: Information on this form may become public. Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Surinder Sachar  
Registration No. 34,423



22850

**SIGNATURE**

*Surinder Sachar*

**C. Irvin McClelland**

**NAME**

21,124

**REGISTRATION NUMBER**

Feb. 22 2002

**DATE**

219734US-3PCT

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF :  
DAIRI KUBO ET AL. : ATTN: APPLICATION DIVISION  
SERIAL NO: NEW U.S. PCT APPLICATION :  
(Based on PCT/JP99/04516)  
FILED: HEREWITH :  
FOR: GAS GENERATOR FOR :  
ACTUATING VEHICLE OCCUPANT  
RESTRAINT DEVICE

PRELIMINARY AMENDMENT

ASSISTANT COMMISSIONER FOR PATENTS  
WASHINGTON, D.C. 20231

SIR:

Prior to a first examination on the merits, please amend the above-identified application as follows:

IN THE SPECIFICATION

Please amend the specification as follows:<sup>1</sup>

Page 1, in the section title at line 1, please replace as follows:

TITLE

Page 4, please replace the section title at line 4 as follows:

SUMMARY OF THE INVENTION

Page 4, please replace the paragraph at lines 5-9 as follows:

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<sup>1</sup>A marked-up copy of all the presently submitted amendments is attached to the present response.

As a result of eager investigation of the present inventors to solve the above-mentioned problem, the present inventors have found that it is important to regulate a ratio of an empty space to an inner volume of the first hollow body to achieve the present invention.

Page 4, please replace the paragraph at lines 10-19 as follows:

The present invention relates to a gas generator for actuating a vehicle occupant restraint device comprising a first hollow body with a bottom and sides, gas generants densely filled in the first hollow-body, an electric ignitor formed by housing igniting agents in a second hollow body with a bottom and sides then closing the second hollow body with a plug, and a holder positioning the second hollow body in the center of the first hollow body while fixing the first hollow body and holding the plug of the electric ignitor.

Page 4, please replace the paragraph beginning at line 20 to page 5, line 5, as follows:

In a first gas generator of the present invention, a ratio of an empty space to a volume of a space partitioned by an inner surface of the first hollow body, an outer surface of the second hollow body and the holder (hereinafter it is described as full volume) is less than 20 % by volume. The empty space and the ratio of the empty space by volume are calculated by using

empty space = full volume - filling volume ••• (1)

ratio of an empty space by volume

= (empty space volume / full volume) X 100 ••• (2)

Page 5, please replace the paragraph at lines 11-17 as follows:

According to the first gas generator of the present invention, because the ratio of the empty space to the full volume of the first hollow body is less than 20 %, the first hollow body is substantially full of the gas generants. Therefore, ignition energy of the electric

ignitor is transmitted efficiently and the time for raising for inner pressure of the first hollow body is shortened.

Page 5, please replace the paragraph at line 18 to page 6, line 2, as follows:

Accordingly, in the case an electrical ignitor with small ignition power is used, there is no possibility that an ignition delay occurs. In addition, because the first hollow body is substantially full of the gas generants, the gas generants are prevented from being powdered by vibration of vehicles. To ensure the above-mentioned action, it is preferable that the ratio of empty space is less than 15 %, further preferably, less than 10%.

Page 6, please replace the paragraph at lines 5-11 as follows:

A second gas generator of the present invention is characterized in that the gas generants are powdery or granulated and filled in a compressed state, in addition to the above-mentioned characteristics of the first gas generator. As examples of compressible gas generants, there are powdery or granulated non-azide gas generants, propellant gas generants and the like.

Page 7, please replace the paragraph at lines 8-13 as follows:

A third gas generator of the present invention is characterized in that a part of the full volume is filled with a spacer inserted between outer surfaces of the sides of the second hollow body and inner surfaces of the sides of the first hollow body, in addition to the above-mentioned characteristics of the first or the second gas generator.

Page 7, please replace the paragraph at lines 14-23 as follows:

According to the third gas generator of the present invention, an empty space between the outer surfaces of the sides of the second hollow body and the inner surfaces of the sides of the first hollow body can be filled with the spacer. Therefore, even if a form of the gas generator cannot be modified for reason of a design of a vehicle occupant restraint device, it

is possible to lower the ratio of the empty space. As a result, the first hollow body is substantially full of the gas generants, thereby an excellent ignitability is obtained.

Page 8, please replace the paragraph beginning at line 21 to page 9, line 3, as follows:

A fourth gas generator of the present invention is characterized in that the gas generants are compressed in advance and filled in the first hollow body so that a concavity, in which the second hollow body is inserted, is formed, in addition to the above-mentioned characteristics of the first or the second gas generator.

Page 9, please replace the paragraph at lines 4-15 as follows:

According to the fourth gas generator of the present invention, the gas generants are compressed in the first hollow body in advance so that the concavity, in which the second hollow body is inserted, is formed. Therefore, when the second hollow body is inserted into the first hollow body, the second hollow body is surrounded by the gas generants. The ignition energy of the electric ignitor is transmitted to the gas generants surrounding the second hollow body without waste. Therefore, there is no possibility that an ignition delay occurs. For compressing the gas generants into a concave shape in the first hollow body, convex compressing tools may be used.

Page 9, please replace the paragraph at lines 16-22 as follows:

A fifth generator of the present invention is characterized in that gas generants incompressible or hard to compress are filled densely and a part of the full volume is filled with the spacer inserted between the outer surfaces of the sides of the second hollow body and the inner surfaces of the sides of the first hollow body, in addition to the above-mentioned characteristics of the first gas generator.

Page 12, please replace the paragraph at lines 7-15 as follows:

The spacer 7 is, for example, in a cylindrical shape, where a diameter of the inner circumference thereof is substantially the same with the one of the outer circumference of the second hollow body 4a and a diameter of the outer circumference thereof is substantially the same with the axle of the inner circumferences of the first hollow body 2. The spacer 7 is inserted between the outer surfaces of the sides of the second hollow body 4a and the inner surfaces of the sides of the first hollow body 2.

#### IN THE CLAIMS

Please cancel Claims 1-5 without prejudice.

Please add new Claims 6-12 as follows:

6. (New) A gas generator for actuating a vehicle occupant restraint device comprising:
  - a first hollow body with a bottom and sides;
  - gas generants filled densely in the first hollow body;
  - an electric ignitor formed by housing igniting agents in a second hollow body with a bottom and sides, and closing the second hollow body with a plug; and
  - a holder positioning the second hollow body in a center of the first hollow body and fixing the first hollow body while holding the plug of the electric ignitor, wherein a ratio of an empty space to a full volume of a space partitioned by an inner surface of the first hollow body, an outer surface of the second hollow body, and the holder is less than 20% by volume.

7. (New) The gas generator for actuating a vehicle occupant restraint device according to claim 6, wherein the gas generants are powdery or granulated, and filled in a compression state.

8. (New) The gas generator for actuating a vehicle occupant restraint device according to claim 6, wherein a part of the full volume is filled with a spacer inserted between outer surfaces of the sides of the second hollow body and inner surfaces of the sides of the first hollow body.

9. (New) The gas generator for actuating a vehicle occupant restraint device according to claim 7, wherein a part of the full volume is filled with a spacer inserted between outer surfaces of the sides of the second hollow body and inner surfaces of the sides of the first hollow body.

10. (New) The gas generator for actuating a vehicle occupant restraint device according to claim 6, wherein the gas generants are compressed in advance and filled in the first hollow body so that a concavity in which the second hollow body is inserted is formed.

11. (New) The gas generator for actuating a vehicle occupant restraint device according to claim 7, wherein the gas generants are compressed in advance and filled in the first hollow body so that a concavity in which the second hollow body is inserted is formed.

12. (New) The gas generator for actuating a vehicle occupant restraint device according to claim 6, wherein the gas generants, being incompressible or hard to compress, are filled densely and a part of the full volume is filled with a spacer inserted between outer surfaces of the sides of the second hollow body and inner surface of the sides of the first hollow body.

IN THE ABSTRACT OF THE DISCLOSURE

Please cancel the original Abstract on page 24 in its entirety and insert therefor:

## ABSTRACT

A gas generator for actuating a vehicle occupant restraint device, including a first hollow body with a bottom and sides, gas generants filled densely in the first hollow body, an electric ignitor formed by housing igniting agents in a second hollow body with a bottom and sides, and closing the second hollow body with a plug, and a holder positioning the second hollow body in a center of the first hollow body and fixing the first hollow body while holding the plug of the electric ignitor. Particularly, a ratio of an empty space to a full volume of a space partitioned by an inner surface of the first hollow body, an outer surface of the second hollow body, and the holder is less than 20% by volume.

REMARKS

Favorable consideration of this application, as presently amended, is respectfully requested.

The present Preliminary Amendment is submitted to place the above-identified application in more proper format under United States practice.

By the present Preliminary Amendment the Summary of the Invention section is amended to no longer recite any reference numerals. The specification is also amended to correct a minor informality in Equation (2) on page 5 and to clarify at page 12, line 7, that the spacer 7 is not required to be in cylindrical shape but that the cylindrical shape is "an example" of the shape of the spacer 7.

Original Claims 1-5 are canceled and new Claims 6-12 are presented for examination. New Claims 6-12 are deemed to be self-evident from the original disclosure, and thus are not deemed to raise any issues of new matter. New Claims 6-12 are not believed to be more narrow in scope than original Claims 1-5 in any aspect.

A new Abstract believed to be in more proper format under United States practice is also submitted herein.

The present application is believed to be in condition for a full and thorough examination on the merits. An early and favorable consideration of the present application is hereby respectfully requested.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,  
MAIER & NEUSTADT, P.C.



Gregory J. Maier  
Attorney of Record  
Registration No. 25,599  
Surinder Sachar  
Registration No. 34,423



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**Marked-Up Copy**  
Serial No:  
Amendment Filed on:  
\_\_\_\_\_

IN THE SPECIFICATION

Page 1, in the section title at line 1, please replace as follows:

[DESCRIPTIN] TITLE

Page 4, please replace the section title at line 4 as follows:

[DISCLOSURE] SUMMARY OF THE INVENTION

Page 4, please replace the paragraph at lines 5-9 as follows:

As a result of eager investigation of the present inventors to solve the above-mentioned problem, the present inventors have found that it is important to regulate a ratio of an empty space to an inner volume of the first hollow body [2] to achieve the present invention.

Page 4, please replace the paragraph at lines 10-19 as follows:

The present invention relates to a gas generator for actuating a vehicle occupant restraint device comprising a first hollow body [2] with a bottom and sides, gas generants [6] densely filled in the first hollow-body [2], an electric ignitor [4] formed by housing igniting agents [4b] in a second hollow body [4a] with a bottom and sides then closing the second hollow body [4a] with a plug [4c], and a holder [1] positioning the second hollow body [4a]

in the center of the first hollow body [2] while fixing the first hollow body [2] and holding the plug [4c] of the electric ignitor [4].

Page 4, please replace the paragraph beginning at line 20 to page 5, line 5, as follows:

In a first gas generator of the present invention, a ratio of an empty space to a volume of a space partitioned by an inner surface of the first hollow body [2], an outer surface of the second hollow body [4a] and the holder [1] (hereinafter it is described as full volume) is less than 20 % by volume. The empty space and the ratio of the empty space by volume are calculated by using

$$\text{empty space} = \text{full volume} - \text{filling volume} \quad \dots \quad (1)$$

ratio of an empty space by volume

$$= (\text{empty space volume} / \text{full volume}) \times 100 \quad \dots \quad (2)$$

Page 5, please replace the paragraph at lines 11-17 as follows:

According to the first gas generator of the present invention, because the ratio of the empty space to the full volume of the first hollow body [2] is less than 20 %, the first hollow body [2] is substantially full of the gas generants. Therefore, ignition energy of the electric ignitor [4] is transmitted efficiently and the time for raising for inner pressure of the first hollow body is shortened.

Page 5, please replace the paragraph beginning at line 18 to page 6, line 2, as follows:

Accordingly, in the case an electrical ignitor with small ignition power is used, there is no possibility that an ignition delay occurs. In addition, because the first hollow body [2] is substantially full of the gas generants, the gas generants are prevented from being powdered by vibration of vehicles. To ensure the above-mentioned action, it is preferable that the ratio of empty space is less than 15 %, further preferably, less than 10%.

Page 6, please replace the paragraph at lines 5-11 as follows:

A second gas generator of the present invention is characterized in that the gas generants [6] are powdery or granulated and filled in a compressed state, in addition to the above-mentioned characteristics of the first gas generator. As examples of compressible gas generants, there are powdery or granulated non-azide gas generants, propellant gas generants and the like.

Page 7, please replace the paragraph at lines 8-13 as follows:

A third gas generator of the present invention is characterized in that a part of the full volume is filled with a spacer [7] inserted between outer surfaces of the sides of the second hollow body [4a] and inner surfaces of the sides of the first hollow body [2], in addition to the above-mentioned characteristics of the first or the second gas generator.

Page 7, please replace the paragraph at lines 14-23 as follows:

According to the third gas generator of the present invention, an empty space between the outer surfaces of the sides of the second hollow body [4a] and the inner surfaces of the sides of the first hollow body [2] can be filled with the spacer [7]. Therefore, even if a form of the gas generator cannot be modified for reason of a design of a vehicle occupant restraint device, it is possible to lower the ratio of the empty space. As a result, the first hollow body [2] is substantially full of the gas generants [6], thereby an excellent ignitability is obtained.

Page 8, please replace the paragraph beginning at line 21 to page 9, line 3, as follows:

A [forth] fourth gas generator of the present invention is characterized in that the gas generants [6] are compressed in advance and filled in the first hollow body [2] so that a concavity, in which the second hollow body [4a] is inserted, is formed, in addition to the above-mentioned characteristics of the first or the second gas generator.

Page 9, please replace the paragraph at lines 4-15 as follows:

According to the [forth] fourth gas generator of the present invention, the gas generants are compressed in the first hollow body [2] in advance so that the concavity, in which the second hollow body [4] is inserted, is formed. Therefore, when the second hollow body [4a] is inserted into the first hollow body [2], the second hollow body [4a] is surrounded by the gas generants. The ignition energy of the electric ignitor is transmitted to the gas generants surrounding the second hollow body [4a] without waste. Therefore, there is no possibility that an ignition delay occurs. For compressing the gas generants [6] into a concave shape in the first hollow body [2], convex compressing tools may be used.

Page 9, please replace the paragraph at lines 16-22 as follows:

A fifth generator of the present invention is characterized in that gas generants [6] incompressible or hard to compress are filled densely and a part of the full volume is filled with the spacer [7] inserted between the outer surfaces of the sides of the second hollow body [4a] and the inner surfaces of the sides of the first hollow body [2], in addition to the above-mentioned characteristics of the first gas generator.

Page 12, please replace the paragraph at lines 7-15 as follows:

The spacer 7 is, for example, in a cylindrical shape, where a diameter of the inner circumference thereof is substantially the same with the one of the outer circumference of the second hollow body 4a and a diameter of the outer circumference thereof is substantially the same with the axle of the inner circumferences of the first hollow body 2. The spacer 7 is inserted between the outer surfaces of the sides of the second hollow body 4a and the inner surfaces of the sides of the first hollow body 2.

#### IN THE CLAIMS

--Claims 6-12 (New).--

IN THE ABSTRACT

--(New).--

3/Pyts

## DESCRIPTIN

GAS GENERATOR FOR ACTUATING VEHICLE OCCUPANT RESTRAINT DEVICE

## TECHNICAL FIELD

The present invention relates to a gas generator for actuating vehicle occupant restraint device such as pretensioner belts.

## BACKGROUND ART

A pretensioner belt is a vehicle occupant restraint device for detecting collision and subsequently fastening a seat belt. For fastening seat belts, there has been normally employed a mechanism of fastening seat belts by gas pressure of a gas generator.

Such gas generator includes a first hollow body with a bottom and sides, gas generants filled in the first hollow body, an electric ignitor, and a holder. The electric ignitor is formed with a second hollow body with a bottom and sides, igniting agents housed in the second hollow body, and a plug closing an opening portion of the second hollow body. The holder positions the second hollow body in the center of the first hollow body, holding the plug of the electrical ignitor. The holder fixes the second hollow body in the first hollow body, closing the opening portion of the first hollow body.

A first hollow body filled with gas generants and a holder

in which an electrical ignitor is fixed in advance and a second hollow body of the electrical ignitor is projected, are prepared for this kind of gas generator. The holder is put on the first hollow body to close the opening portion thereof and fixed by a proper fixing means. It is difficult to put the holder into the first hollow body without leaving an excessive empty space at this time since the gas generants are hard solid.

Therefore, when the electric ignitor is actuated and the gas generants are ignited, increase in inner pressure by ignition in the first hollow body is slowed because of the excessive empty space in the first hollow body. As a result, a rupture of a rupture member of the first hollow body is delayed and there is an adverse possibility that desired performance cannot be obtained.

Generally, a permissible ignition delay period (the period of time between a start of current flow to the electric ignitor and a start of discharging gas from the gas generator) is within 2 ms for the seat belt pretensioners of automobiles. When the ignition delay period is more than 2 ms, an occupant restraint performance cannot be shown sufficiently.

When excessive empty space exists, a size of a gas generator is extended by the empty space. Further, because the gas generants are not fixed, powdering thereof by vibration of a vehicle is also concerned. When such a powdering

phenomenon occurs, a combustion velocity of the gas generants becomes extremely fast, and then the gas generator may possibly be damaged.

Hence, Japanese Patent Application Laid-Open No. Hei 8-207694 has disclosed a cup-shaped filling cylinder for filling gas generants without leaving an empty space. The second hollow body of the electric ignitor projects inwardly from the bottom of the cup-shaped filling cylinder. The cup-shaped filling cylinder opens upwardly from the second hollow body of the electric ignitor.

First, in the gas generators having the above-mentioned cup-shaped filling cylinder, the gas generants are filled in the cup-shaped filling cylinder thereof without leaving an empty space. Then, the first hollow body is put on the cup-shaped filling cylinder to cover the opening portion of the cup-shaped filling cylinder. When the gas generants are filled in the first hollow body in this way, it is possible to fix the second hollow body of the electric ignitor in the first hollow body without forming an excessive empty space therein.

However, a filling cylinder needs to be newly provided in this case. As a result, in addition to increase of a component count, simplification of the manufacturing process cannot be expected.

It is an object of the present invention to provide a

gas generator for actuating vehicle occupant restraint device with a small component count, excellent in ignitability, and capable of being miniaturized.

#### DISCLOSURE OF THE INVENTION

As a result of eager investigation of the present inventors to solve the above-mentioned problem, the present inventors have found that it is important to regulate a ratio of an empty space to an inner volume of the first hollow body 2 to achieve the present invention.

The present invention relates to a gas generator for actuating vehicle occupant restraint device comprising a first hollow body 2 with a bottom and sides, gas generants 6 densely filled in the first hollow body 2, electric ignitor 4 formed by housing igniting agents 4b in a second hollow body 4a with a bottom and sides then closing the second hollow body 4a with a plug 4c, and a holder 1 positioning the second hollow body 4a in the center of the first hollow body 2 while fixing the first hollow body 2 and holding the plug 4c of the electric ignitor 4.

In a first gas generator of the present invention, a ratio of an empty space to a volume of a space partitioned by an inner surface of the first hollow body 2, an outer surface of the second hollow body 4a and the holder 1 (hereinafter it is described as full volume) is less than 20 % by volume. The

empty space and the ratio of the empty space by volume are calculated by using

$$\text{empty space} = \text{full volume} - \text{filling volume} \cdots (1)$$

ratio of an empty space by volume

$$= \text{empty space volume} / \text{full volume} \times 100 \cdots (2)$$

Fundamentally, a space that exists among the particles of filled gas generant compositions is not regarded as a gap. And the filling volume means a necessary volume for gas generants filled in a dense state to substantially exist in the full volume.

According to the first gas generator of the present invention, because the ratio of the empty space to the full volume of the first hollow body 2 is less than 20 %, the first hollow body 2 is substantially full of the gas generants. Therefore, ignition energy of the electric ignitor 4 is transmitted efficiently and the time for raising for inner pressure of the first hollow body is shortened.

Accordingly, in the case an electrical ignitor with small ignition power is used, there is no possibility that an ignition delay occurs. In addition, because the first hollow body 2 is substantially full of the gas generants, the gas generants are prevented from being powdered by vibration of vehicles. To ensure above-mentioned action, it is preferable that the

ratio of empty space is less than 15 %, further preferably, less than 10 %.

The conventional cup-shaped filling cylinder is not necessary, thereby providing reduction of component count.

A second gas generator of the present invention is characterized in that the gas generants 6 are powdery or granulated and filled in a compressed state, in addition to the above-mentioned characteristics of the first gas generator. As examples of compressible gas generants, there are powdery or granulated non-azide gas generants, propellant gas generants and the like.

According to the second gas generator of the present invention, the gas generants are powdery or granulated. Therefore, the gas generants can be filled without leaving space and a ratio of the empty space can be easily predetermined. Because the gas generants are filled in a compressed state, the filling density is heightened and the gas generator is miniaturized. Combustion velocity can be adjusted by adjusting a filling weight and a compression height (i.e.a height of a surface formed with the filled agents). It is preferable that the average particle size of material of the powdery or granulated gas generants is adjusted so as to fall into the range of 10-300  $\mu\text{m}$  including 10  $\mu\text{m}$  and 300  $\mu\text{m}$ . It is preferable that the compression degree of the gas generants falls into the range of 30-100% including 30% and 100% in case

that the compression degree of the gas generants is regarded as 100% when the gas generants are compressed with the density equal to the true density.

The powdery or granulated gas generants, adjusted to be in the predetermined range mentioned above, can be hardened into a predetermined form by compression at a predetermined pressure.

A third gas generator of the present invention is characterized in that a part of the full volume is filled with a spacer 7 inserted between outer surfaces of the sides of the second hollow body 4a and inner surfaces of the sides of the first hollow body 2, in addition to the above-mentioned characteristics of the first or the second gas generator.

According to the third gas generator of the present invention, an empty space between the outer surfaces of the sides of the second hollow body 4a and the inner surfaces of the sides of the first hollow body 2 can be filled with the spacer 7. Therefore, even if a form of the gas generator cannot be modified for reason of a design of a vehicle occupant restraint device, it is possible to lower the ratio of the empty space. As a result, the first hollow body 2 is substantially full of the gas generants 6, thereby an excellent ignitability is obtained.

An empty space in this gas generator is calculated by using

empty space

= full volume - ( filling volume + volume of a spacer)

... (1')

Further, when the length of the spacer is adjusted according to the lengths of the first hollow body and the second hollow body, it is possible to adjust the full length of the gas generator without eliminating an excellent ignitability.

Particularly, a configuration where the spacer is located around the electric ignitor, is desirable. The electric ignitor may be formed so as to include the spacer depending on circumstances. Thereby, ignition energy is concentrated on the gas generants, and the ignitability is maintained. The spacer remains fixing on the electric ignitor after the gas generator is actuated.

Rigid material is desirable for the spacer. For example, the spacer is made of aluminum, plastic, glass fiber, and the like and formed into a doughnut shape, a mesh shape, and the like. When the spacer is made of a gas generant composition with the same form as mentioned above, it is possible to increase the output of the gas generator.

A forth gas generator of the present invention is characterized in that the gas generants 6 are compressed in advance and filled in the first hollow body 2 so that a concavity,

in which the second hollow body 4a is inserted, is formed, in addition to the above-mentioned characteristics of the first or the second gas generator.

According to the forth gas generator of the present invention, the gas generants are compressed in the first hollow body 2 in advance so that the concavity, in which the second hollow body 4 is inserted, is formed. Therefore, when the second hollow body 4a is inserted into the first hollow body 2, the second hollow body 4a is surrounded by the gas generants. The ignition energy of the electric ignitor is transmitted to the gas generants surrounding the second hollow body 4a without waste. Therefore, there is no possibility that an ignition delay occurs. For compressing the gas generants 6 into a concave shape in the first hollow body 2, convex compressing tools may be used.

A fifth generator of the present invention is characterized in that gas generants 6 incompressible or hard to compress are filled densely and a part of the full volume is filled with the spacer 7 inserted between the outer surfaces of the sides of the second hollow body 4a and the inner surfaces of the sides of the first hollow body 2, in addition to the above-mentioned characteristics of the first gas generator.

In the gas generator of the present invention described above, the excessive empty space in the first hollow body can be reduced, thereby improving the problem for an ignition delay

of the gas generator. Further, the gas generants are prevented from being powdered by vibration of vehicles. Thus, the gas generator of the present invention is excellent in ignitability and reduced in size though it is manufactured in a manufacturing process almost the same with the conventional one.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of the embodiment 1 of the present invention; FIG. 2 is a sectional view of the embodiment 2 of the present invention; FIG. 3 is Table 1 showing the relationship of the ratio of the empty space by volume and ignition delay period of the gas generator.

#### BEST MODE FOR CARRYING OUT THE INVENTION

The embodiments of the present invention will be described below with reference to the drawings.

FIG. 1 is a sectional view of the embodiment 1 of the present invention. FIG. 2 is a sectional view of the embodiment 2 of the present invention.

In FIG. 1 a gas generator 11 includes a first hollow body 2 with a bottom and sides, gas generants 6 filled in the first hollow body 2, an electric ignitor 4, a holder 1, and a spacer 7.

A bottom of the first hollow body 2 is provided with a

rupture portion 2a thin in wall thickness. The first hollow body 2 is press-formed so as to have two sections consisting of a small diametral portion on a bottom side and a large diametral portion which is a main portion. An end of the main portion is bent to be a flange 2b.

The electric ignitor 4 has a second hollow body 4a with a bottom and sides, igniting agents 4b housed in the second hollow body 4a, a plug 4c to close an opening portion of the second hollow body 4a, and two pins 4d standing on the plug 4c. The two pins 4d are connected to a bridge wire (not shown) being in contact with the igniting agents 4b.

The holder 1 fixes the first hollow body 2 positioning the second hollow body 4a in the center of the first hollow body 2. Further, the holder 1 supports the plug 4c by a caulking portion 1b with an O-like ring 5 around an outer circumference of the plug 4c. The O-like ring 5 is employed for use in seal.

The holder 1 projects a part of the second hollow body 4a of the electric ignitor 4 into the first hollow body 2, and allows parts of the pins 4d to be connected to a connector (not shown).

An insulation ring 3 is fitted to a hole 1a in back of the holder 1 to ensure insulation. The caulking portion 1b for supporting the plug 4c is inserted in the opening portion of the first hollow body 2. By the caulking portion 1c of the holder 1 on the flange 2b of the first hollow body 2, the first hollow body 2 is fixed on the holder 1 in a seal condition.

As means for fixing the first hollow body 2 on the holder 1, adhesive, crimping, casting and the like may be employed.

A space partitioned by an inner surface of the first hollow body 2, an outer surface of the second hollow body 4a and the holder 1 is capable of housing gas generants. The gas generants 6 and the spacer 7 are located in this space.

The spacer 7 is in a cylindrical shape, where a diameter of the inner circumference thereof is substantially the same with the one of the outer circumference of the second hollow body 4a and a diameter of the outer circumference thereof is substantially the same with the one of the inner circumferences of the first hollow body 2. The spacer 7 is inserted between the outer surfaces of the sides of the second hollow body 4a and the inner surfaces of the sides of the first hollow body 2.

A length of the cylindrical spacer 7 is determined so that the later-described ratio of the empty space by volume is less than 20 %, in consideration of the later-described filling volume of the gas generants.

In the case that the gas generants 6 are incompressible or hard to compress e.g. smokeless powder or press-formed non azide gas generants, the gas generants are densely filled in the first hollow body 2 on the bottom side thereof. In the case that the gas generants 6 are compressible and powdery or granulated, the gas generants are densely filled in the first

hollow body 2 on the bottom side thereof in condition hardened by a compression.  $h$  in the drawing refers to a distance between the bottom of the first hollow body 2 and the filling surface (i.e. the surface formed with filled agents).

It is possible to increase a weight of the gas generants 6 by shortening the length of the spacer 7. Further, when the spacer 7 is made of a gas generant composition, a space for housing the gas generants of the first hollow body 2 is not wasted and the amount of generated gas can be increased.

The volume of a space, which is partitioned by an inner surface of the first hollow body 2, an outer surface of the second hollow body 4a and the holder 1 and capable of housing the gas generants, is written with a word of a full volume.

According to the present invention, a volume and a form of the spacer 7 and a filling volume of gas generants are determined so that the ratio of an empty space, which is not filled with the spacer 7 and the gas generants, to the full volume is less than 20 % by volume, preferably less than 10 %.

Fundamentally, a space that exists among the particles of filled gas generant compositions is not regarded as a gap. And the filling volume means a necessary volume for gas generants filled in a dense state to substantially exist in the full volume.

Specifically, the filling volume of the gas generants filled in the first hollow body 2 on the bottom side thereof,

to fit a space for housing the gas generants of the gas generator. Therefore, it is preferable to use the spacer not to form an excessive empty space.

The above-mentioned gas generator is manufactured by the following steps. In the case that the gas generants are incompressible or hard to compress e.g. smokeless powder or press-formed non azide gas generants, the gas generants are densely filled in the first hollow body 2 on the bottom side thereof. In the case that the gas generants 6 are compressible and powdery or granulated, the gas generants are densely filled in the first hollow body 2 on the bottom side thereof in the state hardened by compression.

The electric ignitor 4 is supported by the holder 1 and the spacer 7 is fitted around the outer circumference of the second hollow body 4a of the electric ignitor 4. Then, the holder 1 is fitted to the first hollow body 2 and fixed by the caulking portion 1c. Thus, the gas generator of which inner space is regulated, is manufactured in a process almost the same with the conventional one.

FIG. 2 shows a gas generator without a spacer, in which the gas generants 6 are compressed to be concave to fit the second hollow body 4a. The gas generants 6, which are powdery or granulated and compressible, are suitable. The portions functioning the same way with those of FIG. 1 are referred to by the same reference numerals and the description is omitted.

shown in FIG. 1, is calculated in consideration of a distance  $h$  between the bottom of the first hollow body 2 and the filling surface (i.e. a surface formed with the filled agents), an inner diameter of the first hollow body 2, and an outer diameter of the second hollow body 4a.

A volume of the empty space and the ratio thereof are calculated by using

volume of an empty space.

$$= \text{full volume} - (\text{filling volume} + \text{volume of a spacer}) \quad \cdots \quad (1')$$

ratio of an empty space by volume

$$= \text{empty space volume} / \text{full volume} \times 100 \quad \cdots \quad (2)$$

In the gas generator where the gas generants 6 and the spacer 7 are located, it is possible that the ratio of the empty space to the full volume is less than 20 %, further, less than 10 %. The full volume is a volume of the space partitioned by the inner surface of the first hollow body 2, the outer surface of the second hollow body 4a and the holder 1.

Particularly, in the case that the gas generants are incompressible or hard to compress e.g. smokeless powder or press-formed non azide gas generants, the gas generants cannot be hardened into a predetermined shape by a compression so as

The gas generants 6, which are compressible and powdery or granulated, are densely filled in the first hollow body 2 on the bottom side thereof in the state hardened by a compression to have a concavity 6a to which the second hollow body 4a of the electric ignitor 4 is just fitted. H in the drawing refers to a distance between the bottom of the first hollow body 2 and the filling surface (i.e. a surface formed with the filled agents).

In the embodiments of the present invention, a filling volume of the gas generants 6 are determined so that the ratio of an empty space, which is not filled with the gas generants 6, to the full volume is less than 20 % by volume, preferably less than 10 %.

In the case that the gas generants 6 are compressed in the first hollow body 2 in advance to be concave to fit the second hollow body 4a as described above, the second hollow body 4a is surrounded by the gas generants only by inserting the second hollow body 4a in the first hollow body 2 and fixing by the caulking portion 1c of the holder 1. Therefore, the inner empty space of the gas generator is reduced compared to the conventional one.

In a case that compression degree of the gas generants in the above-mentioned gas generator of the present invention compressed until being equal to the true density thereof is regarded as 100 %, compression degree preferably falls in a

range of 30-100 % including 30% and 100 % so that the gas generants can be compressed into a predetermined form. Concretely, the compression degree is calculated by using

compression degree [%]

$$\begin{aligned} &= (\text{weight of gas generants per } 1 \text{ cm}^3 \text{ of a filling volume} \\ &\quad \div \text{true density of gas generants}) \times 100 \end{aligned} \quad \cdots \quad (4)$$

In the following, the examples of the present invention will be described in detail. All members included in the gas generators employed in the following examples and comparative examples, such as electric ignitors, O-like rings or holders, are of the same standard or type.

[Example 1]

In the gas generator shown in FIG. 2, the gas generants containing 33.8 % by weight of 5-aminotetrazole, 30.5 % by weight of ammonium perchlorate, 31.0 % by weight of strontium nitrate, and 4.7 % by weight of synthetic hydrotalcite were employed. The true density was 2.18 g/cm<sup>3</sup>. The gas generants were powdery, of which particle mean diameter is 50  $\mu\text{m}$ , and compressible.

A gas generants of 1.9 g were weighed and filled in the first hollow body. Then, the gas generants were compressed for forming a concavity until the filling volume was 2.11 cm<sup>3</sup>.

The full volume of the gas generator is  $2.3 \text{ cm}^3$ . The empty space calculated by the equation is 0.19 and the ratio is 8.3 % by volume. The weight of the gas generants per 1  $\text{cm}^3$  of the filling volume is 0.9 g and the compression degree is 41.3 %.

FIG. 3 shows the ratio of the empty space by volume and ignition delay period of the gas generator obtained in this way as Table 1.

#### [Example 2]

In the gas generator shown in FIG. 2, the same gas generants as those used in the Example 1 were employed. The true density was  $2.18 \text{ g/cm}^3$ . The gas generants were powdery, of which particle mean diameter is  $50 \mu\text{m}$ , and compressible.

The gas generants of 1.7 g were weighed and filled in the first hollow body. Then, the gas generants were compressed for forming a concavity until the filling volume was  $1.89 \text{ cm}^3$ . The full volume of the gas generator is  $2.3 \text{ cm}^3$ . The empty space calculated by the equation is  $0.19 \text{ cm}^3$  and the ratio is 17.8 % by volume. The weight of the gas generants per 1  $\text{cm}^3$  of the filling volume is 0.9 g and the compression degree is 41.3 %.

FIG. 3 shows the ratio of the empty space by volume and ignition delay period of the gas generator obtained in this way as Table 1.

#### [Example 3]

In the gas generator shown in FIG. 1, the spacer of 0.4

cm<sup>3</sup> volume was fixed around the second hollow body of the electric ignitor.

The same gas generants as those used in the Example 1 were employed. The true density was 2.18 g/cm<sup>3</sup>. The gas generants were powdery, of which particle mean diameter is 50  $\mu$ m, and compressible. The gas generants of 1.5 g were weighed and filled in the first hollow body. Then, the gas generants were compressed until the filling volume was 1.67 cm<sup>3</sup>. The full volume of the gas generator is 2.3 cm<sup>3</sup>. The empty space calculated by the equation is 0.23 cm<sup>3</sup> and the ratio is 10.0 % by volume. The weight of the gas generants per 1 cm<sup>3</sup> of the filling volume is 0.9 g and the compression degree is 41.3 %.

FIG. 3 shows the ratio of the empty space by volume and ignition delay period of the gas generator obtained in this way as Table 1.

#### [Example 4]

In the gas generator shown in FIG. 1, the spacer of 0.4 cm<sup>3</sup> volume was fixed around the second hollow body of the electric ignitor.

The gas generants containing 98.0 % by weight of nitrocellulose, 1.0 % by weight of diphenylamine, and 1.0 % by weight of potassium sulfate were employed. The gas generants were incompressible, of which particle is press-formed into a cylindrical shape having 0.7 mm of an outer diameter, 0.2 mm of an inner diameter, and 1.3 mm of a height.

The gas generants of 1.3 g were weighed and filled in the first hollow body. Then the gas generants were filled densely without compression until the filling volume was 1.73 cm<sup>3</sup>. The full volume of the gas generator is 2.3 cm<sup>3</sup>. The empty space calculated by the equation is 0.17 and the ratio is 7.4 % by volume. The weight of the gas generants per 1 cm<sup>3</sup> of the filling volume is 0.75 g.

FIG. 3 shows the ratio of the empty space by volume and ignition delay period of the gas generator obtained in this way as Table 1.

#### [Comparative Example 1]

The gas generator in the Comparative Example 1 is equivalent to the gas generator shown in FIG. 1 except the spacer, and an example of the gas generator where the ratio of the empty space by volume is no less than 20 %.

The same gas generants as those used in the Example 1 were employed. The true density was 2.18 g/ cm<sup>3</sup>. The gas generants were powdery, of which particle mean diameter is 50  $\mu$ m, and compressible.

The gas generants of 1.5 g were weighed and filled in the first hollow body. Then, the gas generants were compressed until the filling volume was 1.67 cm<sup>3</sup>. The full volume of the gas generator is 2.3 cm<sup>3</sup>. The empty space calculated by the equation is 0.63 cm<sup>3</sup> and the ratio is 27.4 % by volume. The weight of the gas generants per 1 cm<sup>3</sup> of the filling volume

is 0.9 g and the compression degree is 41.3 %.

FIG. 3 shows the ratio of the empty space by volume and ignition delay period of the gas generator obtained in this way as Table 1.

Generally, a permissible ignition delay period is in seat belt pretensioners for automobiles is within 2 ms. When a delay more than 2 ms occurs, an occupant restraint performance cannot be shown sufficiently.

According to Table 1, ignition delay period in Example 1, 2, 3, 4 are short being less than 2 ms. The ignition delay period in Comparative Example 1 is substantially longer than 2 ms compared to those in Examples. Accordingly, it is shown that the ratio of the excessive space i.e., the empty space in the first hollow body causes a considerable ignition delay of the gas generator.

#### INDUSTRIAL APPLICABILITY

The gas generator of the present invention is most suitable for actuating vehicle occupant restraint device, particularly, for a gas generator with a small component count, excellent in ignitability, and capable of being miniaturized.

## Claims

1. A gas generator for actuating vehicle occupant restraint device comprising, a first hollow body 2 with a bottom and sides, gas generants 6 filled densely in the first hollow body 2, an electric ignitor 4 formed by housing igniting agents 4b in a second hollow body 4a with a bottom and sides, and closing the second hollow body 4a with a plug 4c, and a holder 1 positioning the second hollow body 4a in a center of the first hollow body 2 and fixing the first hollow body 2 while holding the plug 4c of the electric ignitor 4, wherein

a ratio of an empty space to a full volume of a space partitioned by an inner surface of the first hollow body 2, an outer surface of the second hollow body 4a and the holder 1 is less than 20 % by volume.

2. The gas generator for actuating vehicle occupant restraint device according to claim 1, wherein the gas generants 6 are powdery or granulated, and filled in a compression state.

3. The gas generator for actuating vehicle occupant restraint device according to one of claims 1 or 2, wherein a part of the full volume is filled with a spacer 7 inserted between outer surfaces of the sides of the second hollow body 4a and inner surfaces of the sides of the first hollow body 2.

4. The gas generator for actuating vehicle occupant restraint device according to claim 1 or 2, wherein the gas generants 6 are compressed in advance and filled in the first hollow body 2 so that a concavity in which the second hollow body 4a is inserted is formed.

5. The gas generator for actuating vehicle occupant restraint device according to claim 1, wherein the gas generants 6, being incompressible or hard to compress, are filled densely and a part of the full volume is filled with a spacer 7 inserted between outer surfaces of the sides of the second hollow body 4a and inner surface of the sides of the first hollow body 2.

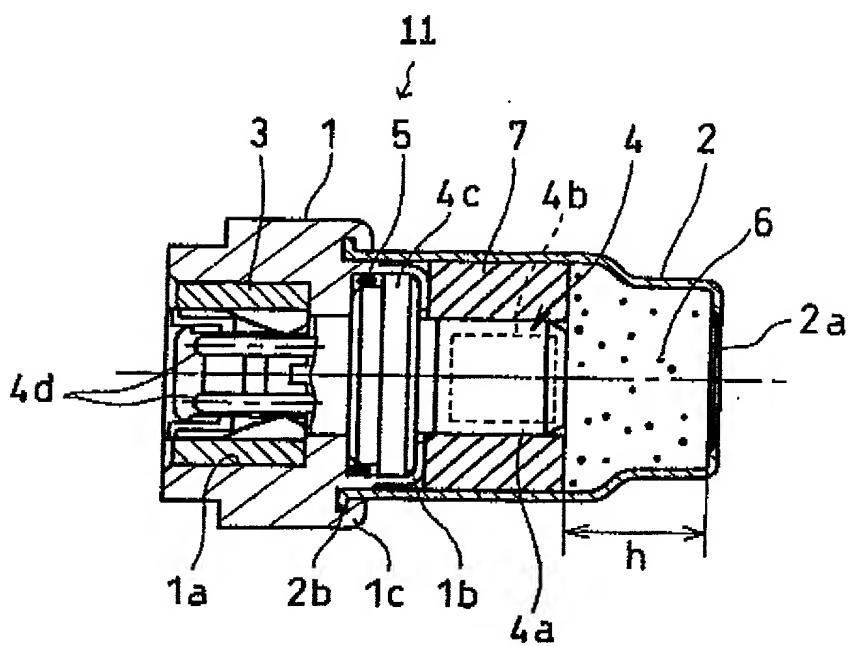
### Abstract

The present invention relates to a gas generator for actuating vehicle occupant restraint device, comprising a first hollow body 2 with a bottom and sides, gas generants 6 filled densely in the first hollow body 2, an electric ignitor 4 formed by housing igniting agents 4b in a second hollow body 4a with a bottom and sides, and closing the second hollow body 4a with a plug 4c, and a holder 1 positioning the second hollow body 4a in a center of the first hollow body 2 and fixing the first hollow body 2 while holding the plug 4c of the electric ignitor 4.

Particularly a ratio of an empty space to a full volume of a space partitioned by an inner surface of the first hollow body 2, an outer surface of the second hollow body 4a and the holder 1 is less than 20 % by volume.

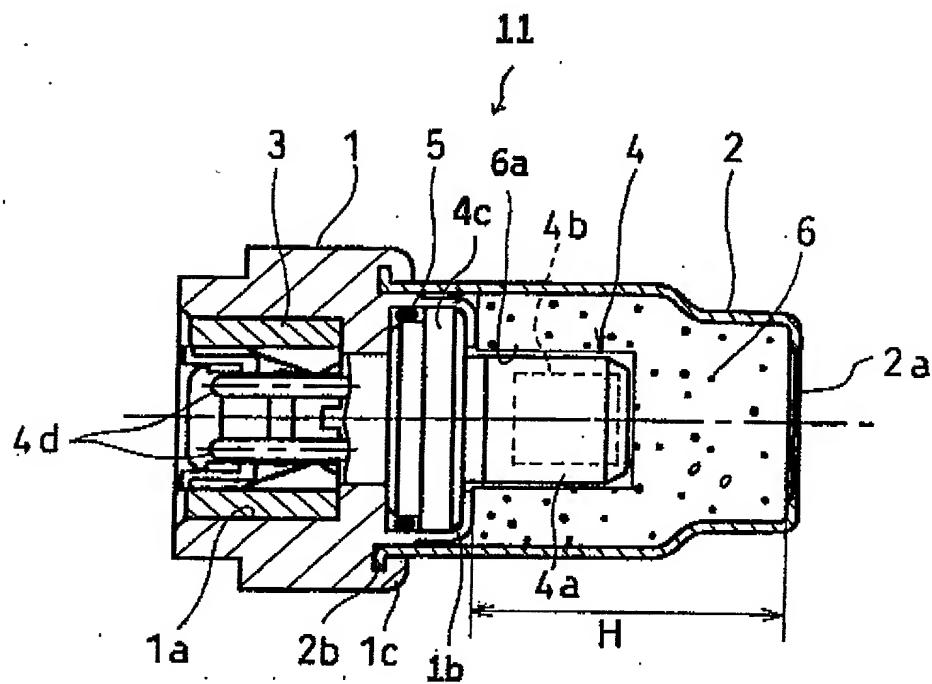
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Fig. 1



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Fig. 2



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Fig. 3

Table 1

	Example 1	Example 2	Example 3	Example 4	Comparative Example 1
Ratio of the empty space by volume [%]	8. 3	17. 8	10. 0	7. 4	27. 4
Ignition delay period [ms]	1. 7	1. 8	1. 7	1. 8	2. 4

## Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

## Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者（下記の名称が複数の場合）であると信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled.

GAS GENERATOR FOR ACTUATING VEHICLE OCCUPANT RESTRAINT DEVICE

上記発明の明細書は、

本書に添付されています。

\_\_\_\_月\_\_\_\_日に提出され、米国出願番号または特許協力条約国際出願番号を\_\_\_\_\_とし、  
(該当する場合) \_\_\_\_\_に訂正されました。

the specification of which

 is attached hereto. was filed on August 23, 1999

as United States Application Number or

PCT International Application Number

PCT/JP00/04516 and was amended on

(if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

## Japanese Language Declaration

## (日本語宣言書)

私は、米国法典第35編119条(a)-(d)項又は365条(b)項に基づき下記の、米国以外の国の少なくとも一ヵ国を指定している特許協力条約365(a)項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

## Prior Foreign Application(s)

## 外国での先行出願

H 1 0 - 4 3 2 7 2	Japan
(Number) (番号)	(Country) (国名)

私は、第35編米国法典119条(e)項に基づいて下記の米国特許出願規定に記載された権利をここに主張いたします。

(Application No.) (出願番号)	(Filing Date) (出願日)

私は、下記の米国法典第35編120条に基づいて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約365条(c)に基づく権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第35編112条第1項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願提出日以降で本出願書の日本国内または特許協力条約国提出日までの期間中に入手された、連邦規則法典第37編1条56項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

PCT/JP99/04516	August 23, 1999
(Application No.) (出願番号)	(Filing Date) (出願日)

(Application No.) (出願番号)	(Filing Date) (出願日)

私は、私自身の知識に基づいて本宣言書で私が行なう表明が真実であり、かつ私の入手した情報と私が信じるところに基づく表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第18編第1001条に基づき、罰金または拘禁、もしくはその両方により处罚されること、そしてそのような故意による虚偽の声明を行なえば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby claim foreign priority under Title 35, United States code, Section119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or Section365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Priority Claimed	
<input type="checkbox"/>	優先権主張
<input checked="" type="checkbox"/>	
Yes	No
はい	いいえ
<input type="checkbox"/>	
Yes	No
はい	いいえ
<input type="checkbox"/>	
Yes	No
はい	いいえ
<input type="checkbox"/>	
Yes	No
はい	いいえ

I hereby claim the benefit under Title 35, United States Code, Section 119 (e) of any United States provisional application(s) listed below.

(Application No.) (出願番号)	(Filing Date) (出願日)

I hereby claim the benefit under Title35, United States Code, Section 120 of any United States application(s), or Section365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title35, United States Code Section112, I acknowledge the the duty to disclose information which is material to patentability as defined in Title37, Code of Federal Regulations, Section1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application.

Pending
(Status: Patented, Pending, Abandoned) (現況: 特許許可済、係属中、放棄済)

(Status: Patented, Pending, Abandoned) (現況: 特許許可済、係属中、放棄済)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

## Japanese Language Declaration

(日本語宣言書)

委任状: 私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。

(弁護士、または代理人の指名及び登録番号を明記のこと)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: (list name and registration number)



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(第三以降の共同発明者についても、同様に記載し、  
署名すること)

(Supply similar information and signature for third and subsequent joint inventors.)

## Japanese Language Declaration

第三共同発明者		Full name of third joint inventor, if any <u>Koiji NAKAMURA</u>	
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第四共同発明者の署名	日付	Fourth Inventor's signature <u>Kenjirō Ikeda</u>	Date <u>JAN. 22. 2002</u>
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国籍	Citizenship		
郵便の宛先	Post Office Address		
第六共同発明者	Full name of sixth joint inventor, if any		
第六共同発明者の署名	日付	Sixth Inventor's signature	Date
住所	Residence		
国籍	Citizenship		
郵便の宛先	Post Office Address		

(第七またはそれ以降の共同発明者に対しても同様な情報および署名を提供すること。)

(Supply similar information and signature for seventh and subsequent joint inventors.)